# $R_{dAu}$ Measurement with Muons from Light Meson Decay

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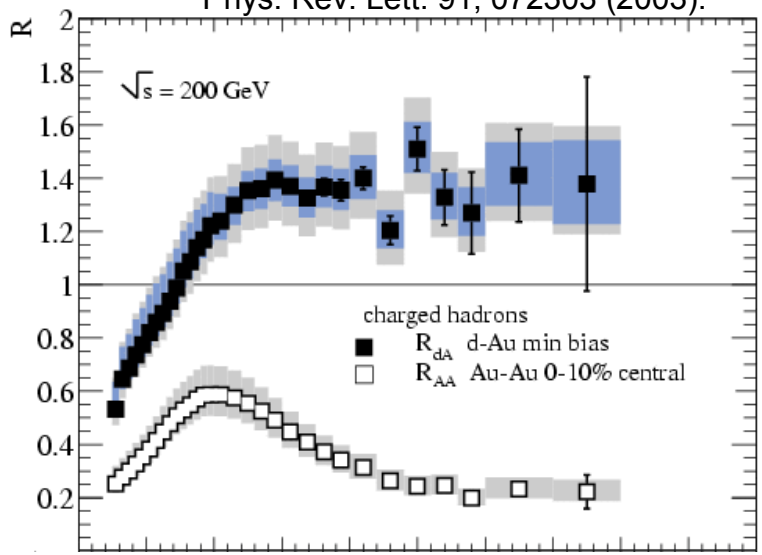
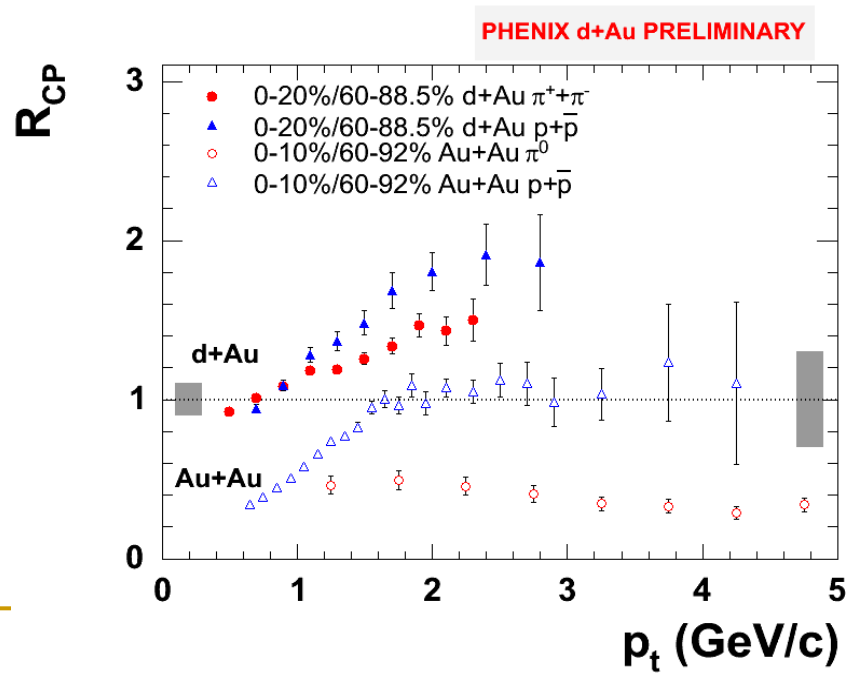
(for the PHENIX Collaboration)

# Motivation

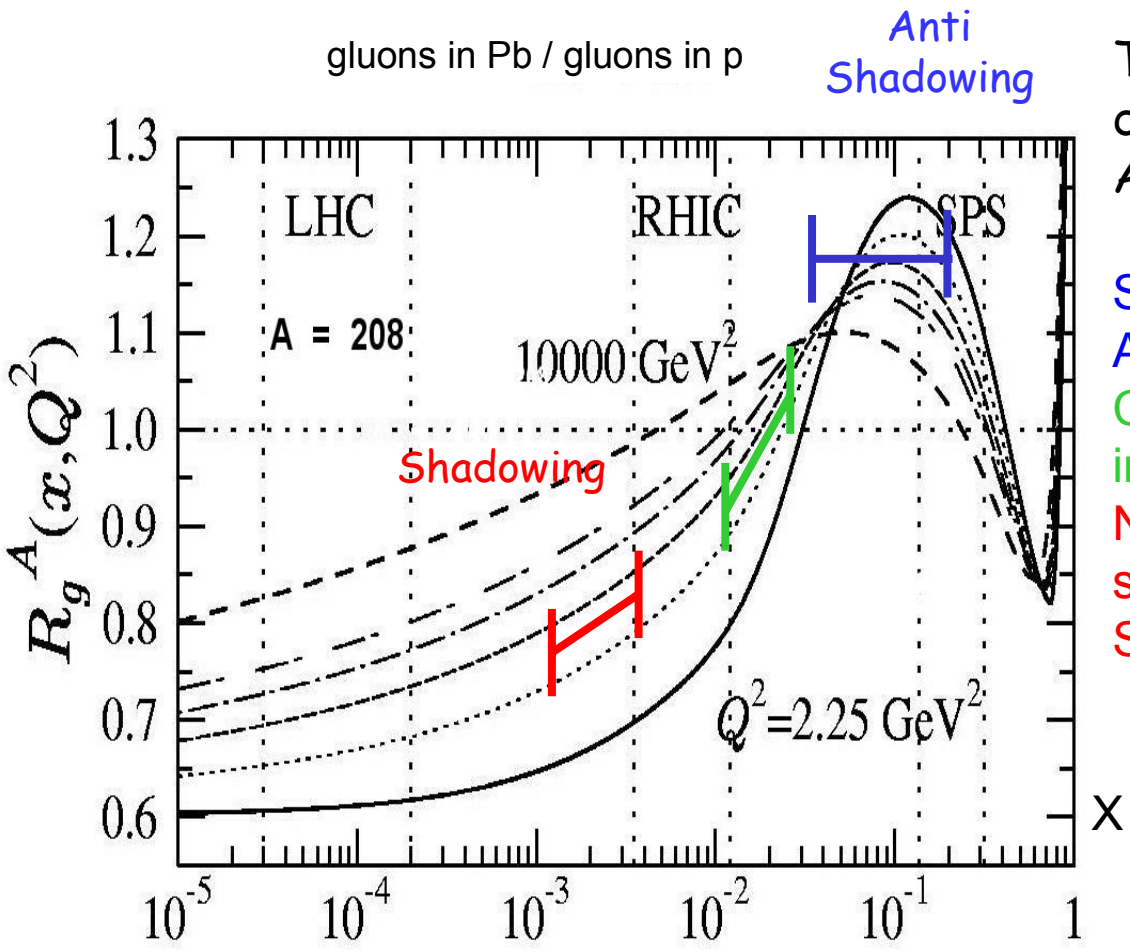
- Striking difference of d+Au and Au+Au results in charged hadron production in central rapidity (y=0)
- Mesons vs baryons
  - Charged hardons:
    - mixture of Meson & Baryons
  - Neutral π: mesons
- What happens in the forward (small x) and backward (large x) rapidity in asymmetric d-Au collisions?

Ref: PHENIX
Phys. Rev. Lett. 91, 072303 (2003).



# Example of predicted gluon shadowing in d+Au



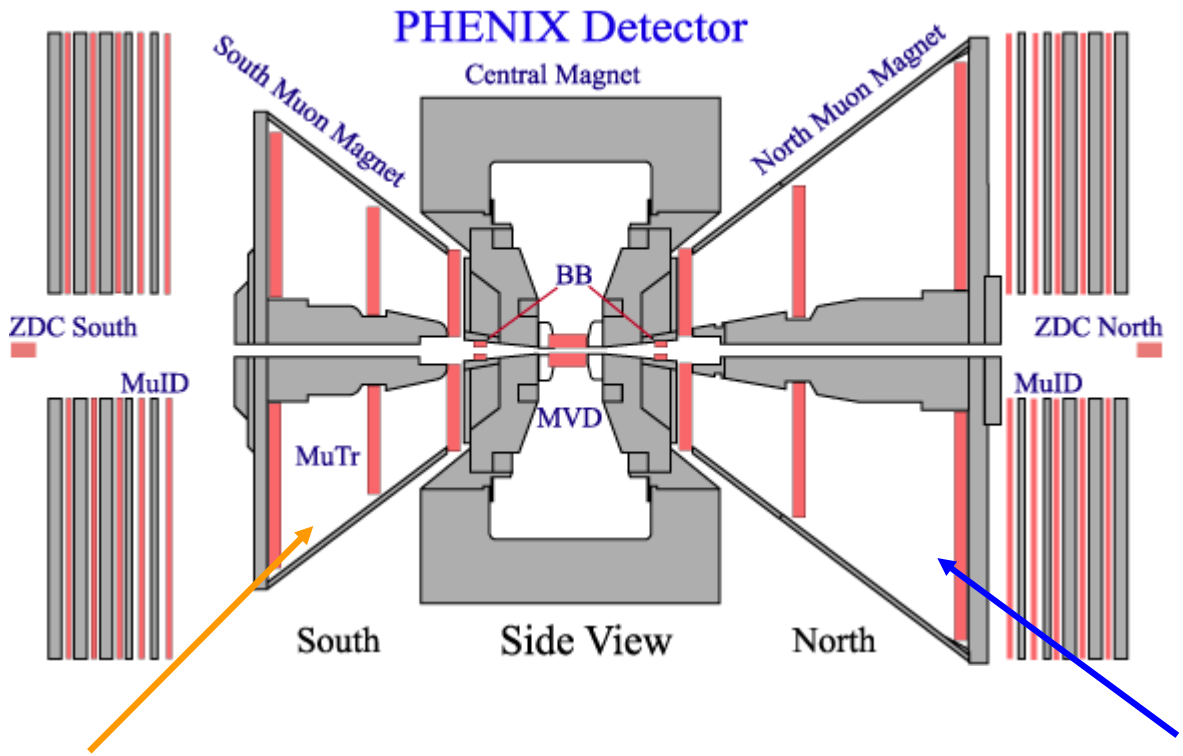

Three rapidity ranges probe different momentum fraction of Au partons

South (y < -1.2) : large $X_{Au}$ ~ 0.090
Anti-shadowing/Cronin regime
Central (y ~ 0) :
intermediate $X_{Au}$ ~ 0.020
North (y > 1.2) :
small X2 ~ 0.003
Shadowing/suppression regime

From Eskola, Kolhinen, Vogt
Nucl. Phys. A696 (2001) 729-746.

# The PHENIX detector

***deuteron*** → ✸ ← ***gold***

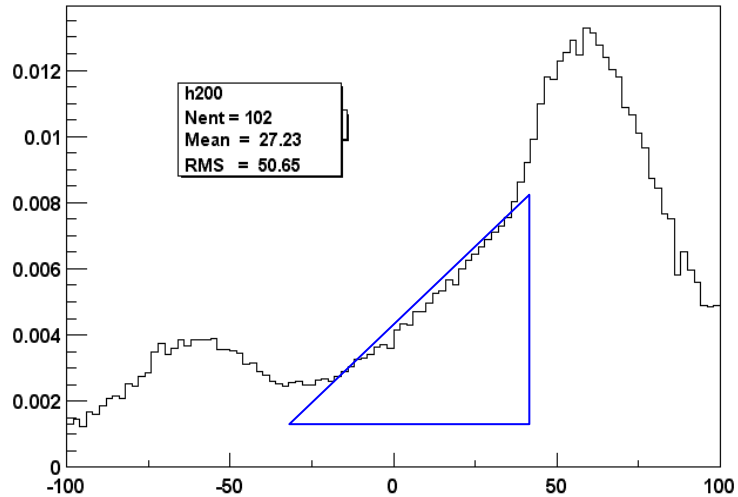



South Muon arm : $-1.2 > \eta > -2.0$

North Muon arm : $2.4 > \eta > 1.2$

$$R^{dAu}(P_T, y) = \frac{\frac{d^2\sigma_\mu{}^{dAu}(P_T, y)}{2\pi P_T dP_T dy} * \frac{1}{2*197}}{\frac{d^2\sigma_\mu{}^{pp}(P_T, y)}{2\pi P_T dP_T dy}};$$

## Normalized Muon Event Z vertex




The normalized muon event vertex distribution

$$\frac{1}{N^{MB}_{measured}(Z)} \frac{d^3N(Z,\eta,P_T^{\mu^\pm})}{dZdP_T^{\mu^\pm}d\eta} \approx \{\alpha(P_T,\overline{\eta})\cdot(Z - Z^0_{eff}) + \beta(P_T,\overline{\eta})\}$$

Decay muons $R_{dAu}$ :

$$R^{decay}_{dAu}(p_T,\eta) = \frac{1}{2\times197} \cdot \frac{\alpha^{dAu}(p_T,\eta)\cdot\frac{\varepsilon^{dAu}_{MB}\cdot\sigma^{dAu}}{\varepsilon^{dAu}_{reco}\cdot(\varepsilon^{\mu}_{BBC}\cdot\varepsilon_{BLT})^{dAu}}}{\alpha^{pp}(p_T,\eta)\cdot\frac{\varepsilon^{pp}_{MB}\cdot\sigma^{pp}}{\varepsilon^{pp}_{reco}\cdot(\varepsilon^{\mu}_{BBC}\cdot\varepsilon_{BLT})^{pp}}}$$

# Trigger efficiency vs vertex for high $p_T$ $\pi^0$ events

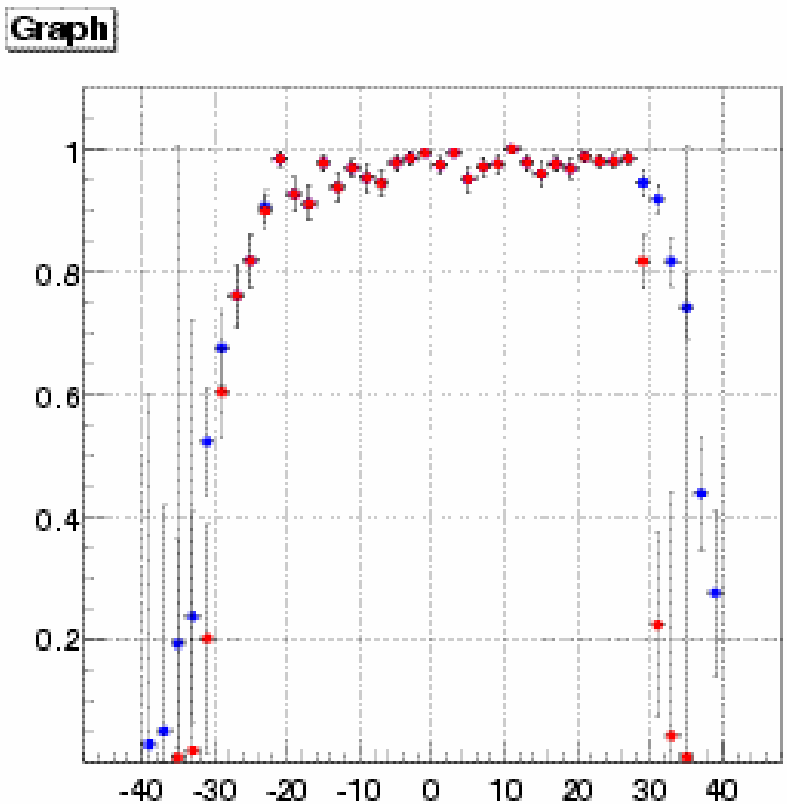
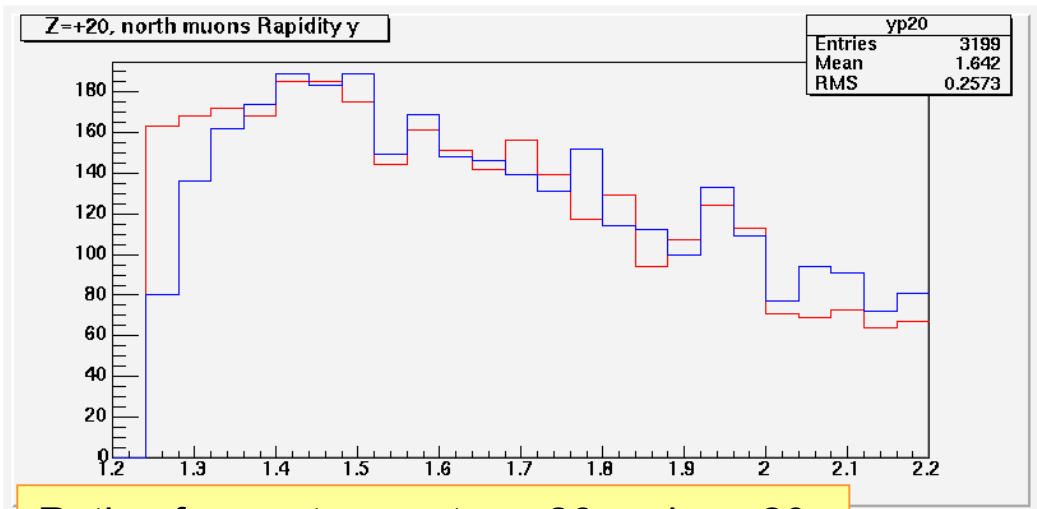



Figure 22: $\epsilon_{\pi^0}$ vs. Z with the 30cm offline vertex cut.

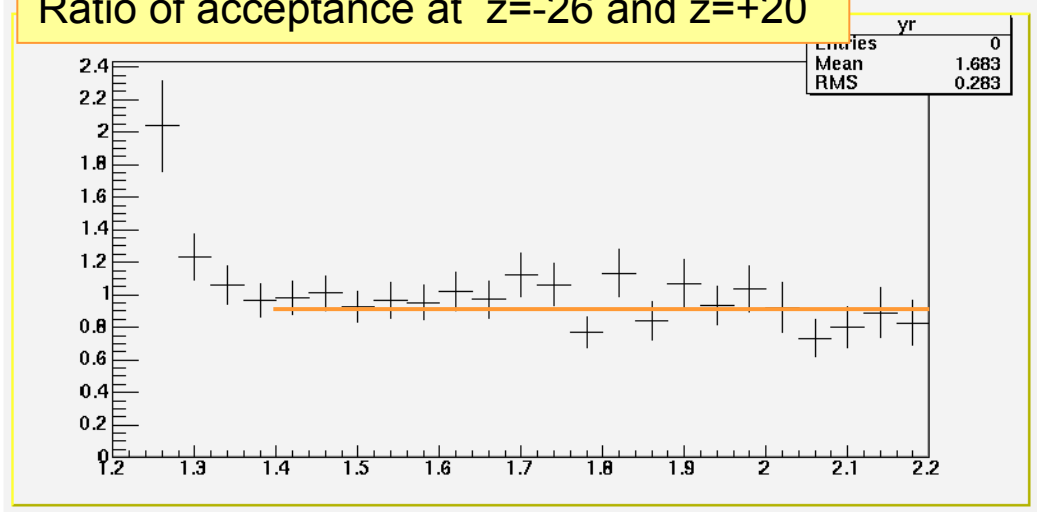
**|vtx| < 26 cm in this analysis**

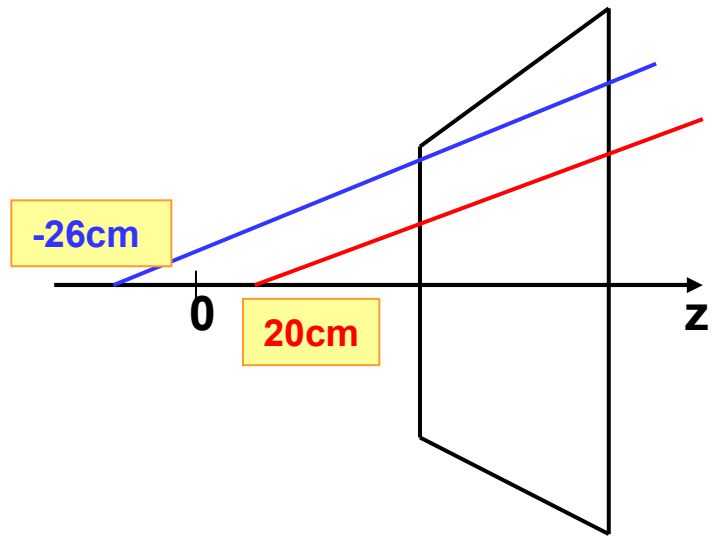
# Single Muon acceptance vs collision Vertex (North)

acceptance for z=-26 (red) and z=+20 (blue)




Ratio of acceptance at z=-26 and z=+20



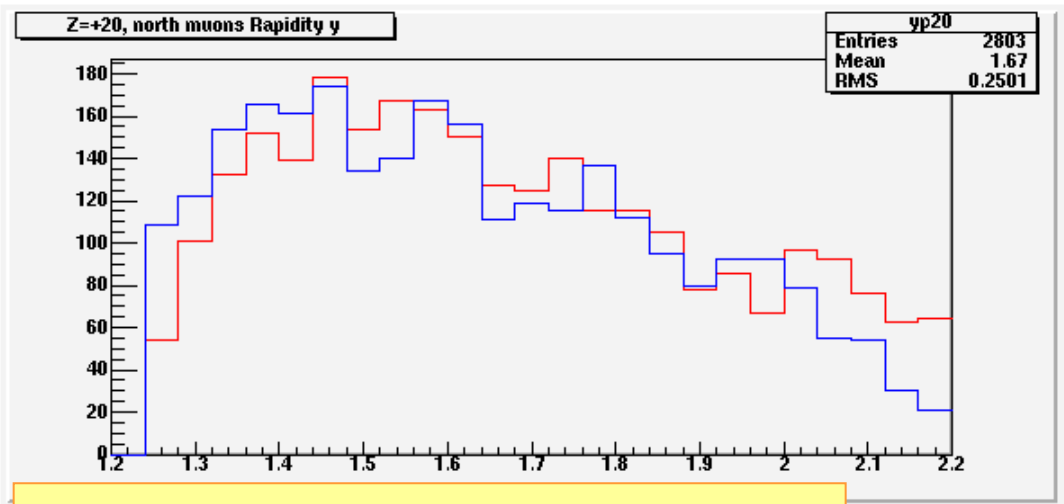

**1.4 < η < 2.2**

**Uniform acceptance in vtx = (-26, 20)**

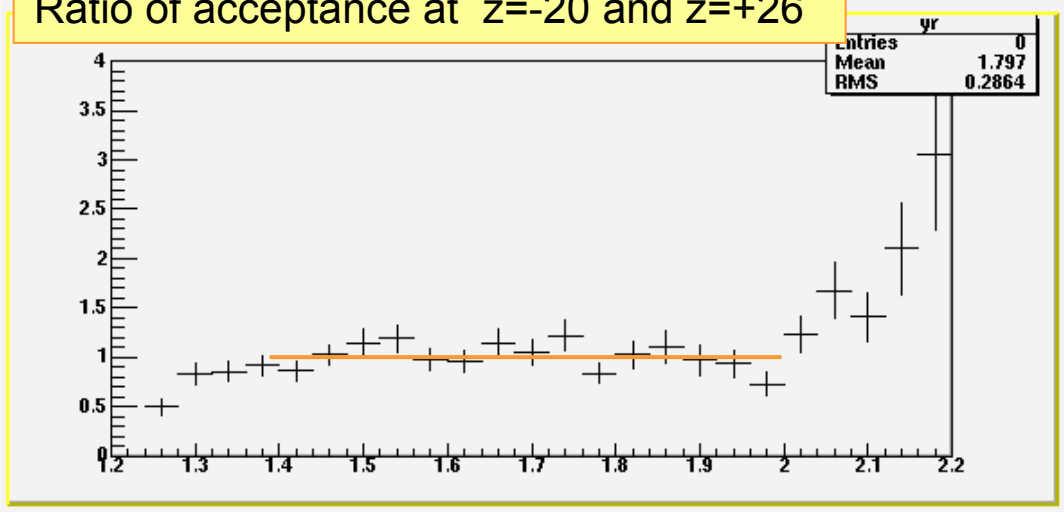
η

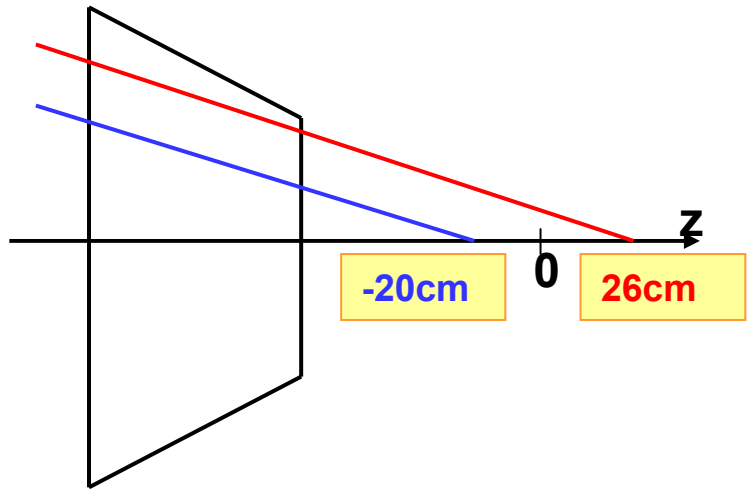
# Single Muon acceptance vs collision Vertex (South)

acceptance for z=-20 (red) and z=+26 (blue)




Ratio of acceptance at z=-20 and z=+26




**$-2.0 < \eta < -1.4$**

**Uniform acceptance in vtx = (-20, 26)**

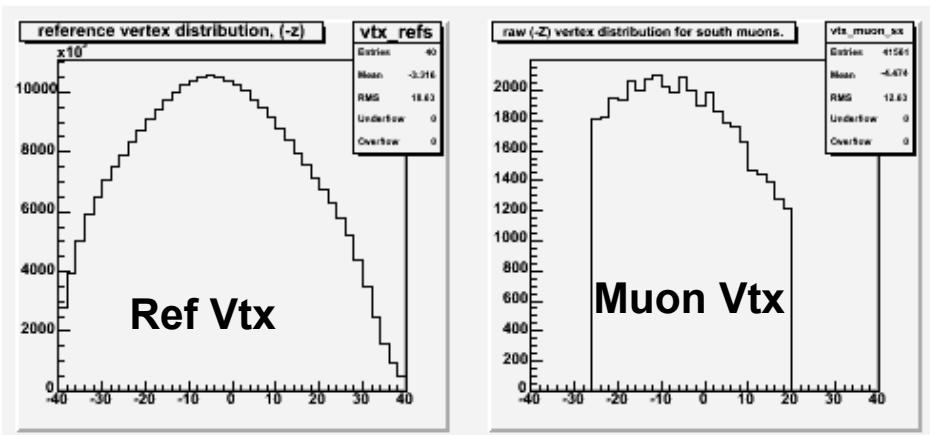
$\eta$

# Run3pp and Run3dAu data samples

- Single muon Minbias and Triggered samples.

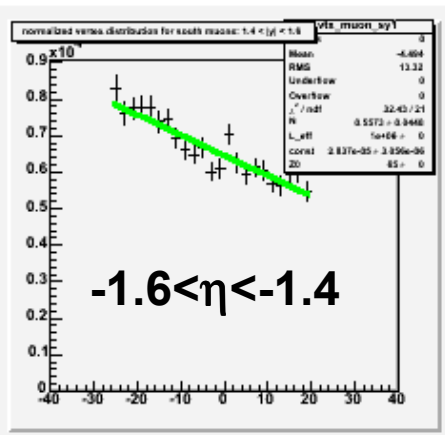
- Taking into consideration the hardware status of the detector and the mean muon production rate for each run, a list of good runs was selected
  - Event vertex cut: abs(bbcZ) < 26cm;
  - Good deep muons quality cuts

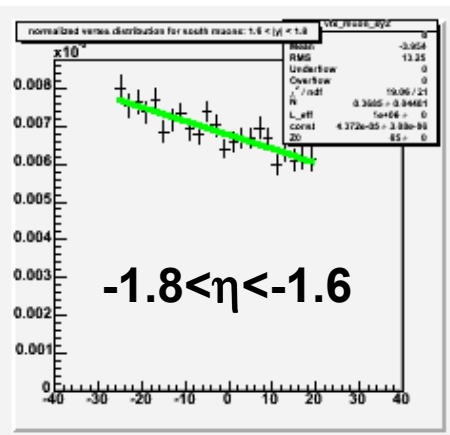
# Vertex Analysis ( dAu South ) (-z)

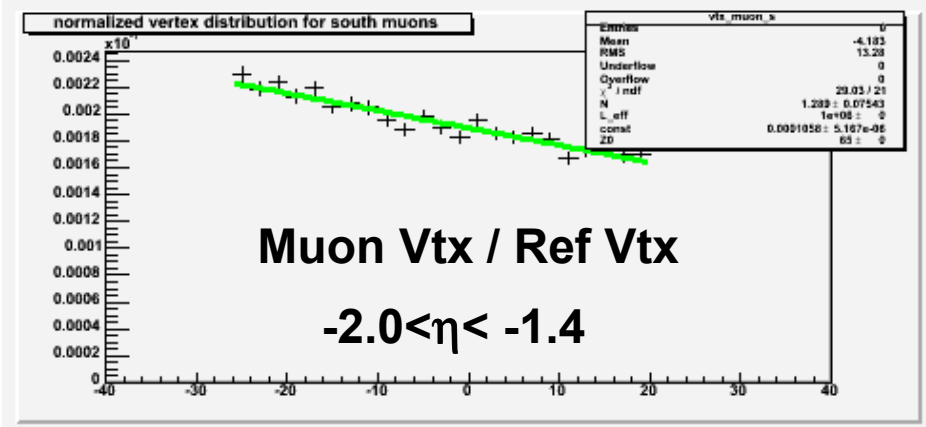


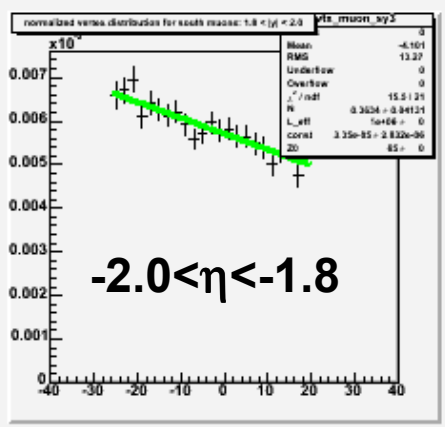




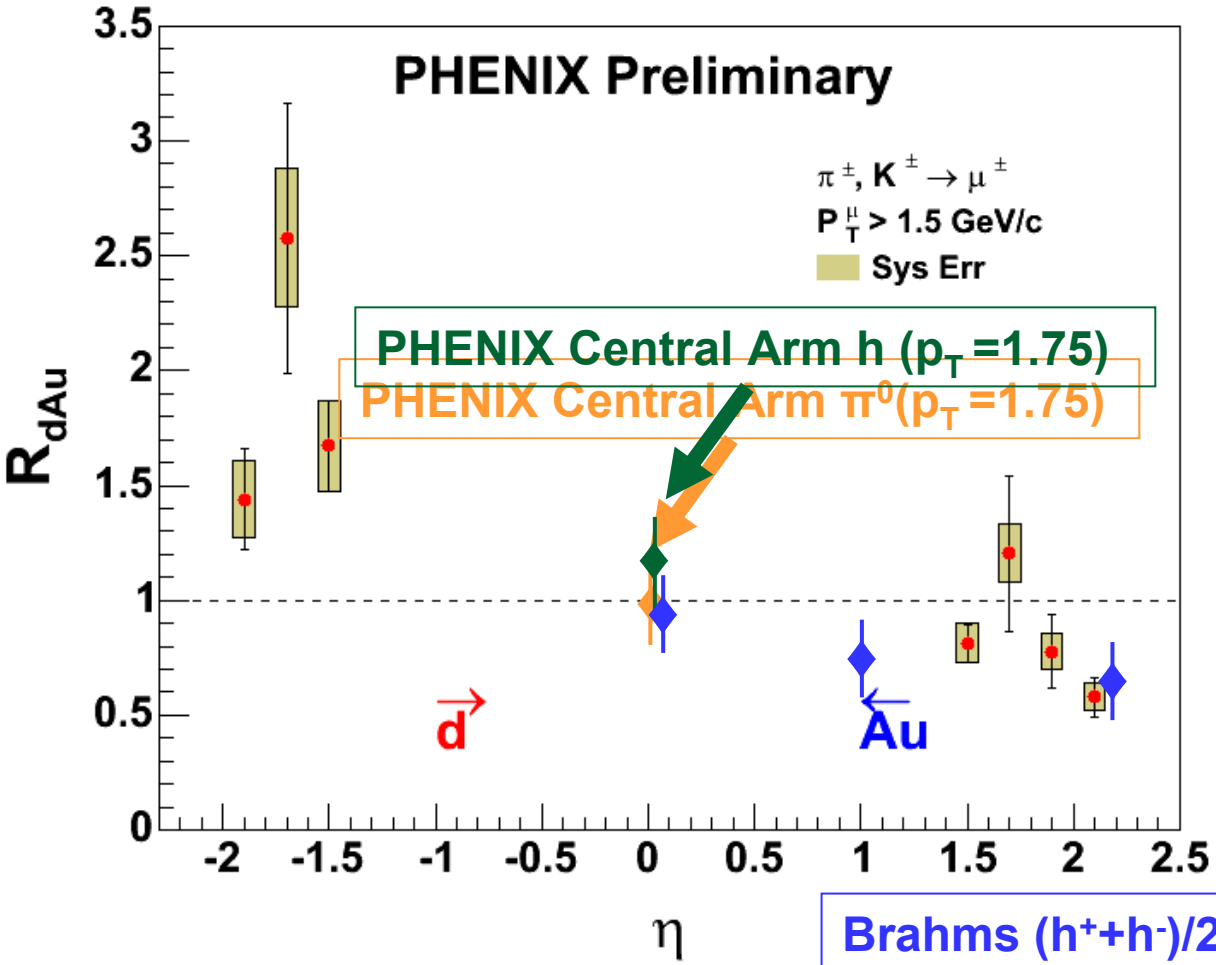


# Decay muons $R_{dAu}$ vs $\eta$




$P_h \approx 1.15 * P_\mu$

Forward:

Suppression!

Backward:

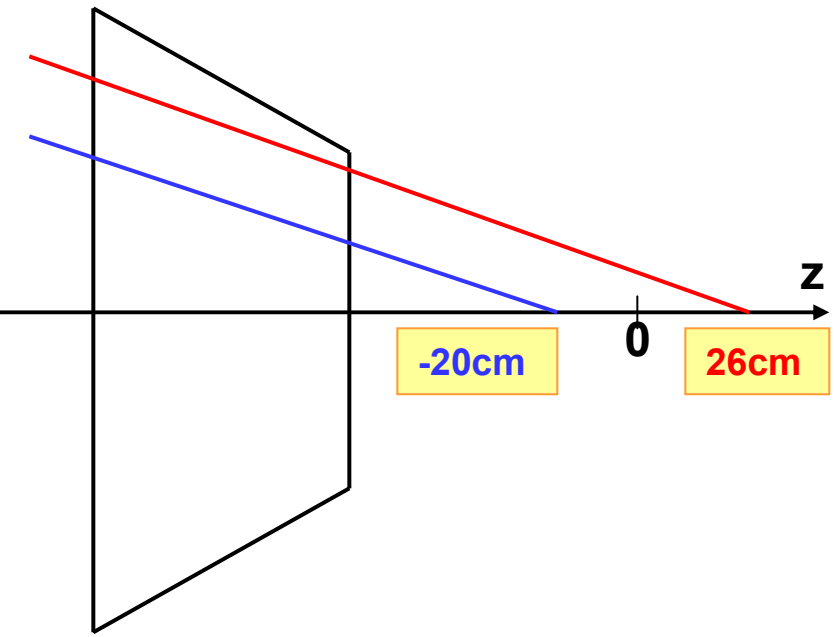
Enhancement!

Brahms $(h^+ + h^-)/2$

($\eta$ =0, 1.0, 2.2) $p_T$ =1.75

# Summary and Outlook

- Light meson nuclear medium modification factor $R_{dAu}$ in forward and backward directions was measured with the PHENIX muon arms.
- Forward (deuteron direction) and backward shows totally different behaviors:
  - Forward regime shows suppression. Shadowing effect observed.
  - Backward shows enhancement. Cronin effect seems dominant in this regime.
- Work in progress
  - Centrality dependence
  - Pt dependence
  - Open Charm


z
0
-20cm
26cm